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INFECTIOUS DISEASE IN BIOCULTURAL PERSPECTIVE: PAST, PRESENT AND FUTURE WORK IN BRITAIN

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INTRODUCTION

The aims of this chapter are to review the types of information which are potentially retrievable from a study of infectious disease in antiquity, and the range of published research already extant worldwide on infectious disease, to document the range and quality of work already completed on British material, and to recommend the way forward and best practice. In such a short chapter it will not be possible to include all aspects of infectious disease in past populations but the more common approaches will be considered. It is of necessity that a biocultural approach needs to be considered. The term refers to the biological evidence for disease within its cultural context, e.g. did the living environment of populations predispose them to infectious disease? While some British researchers in palaeobiological anthropology do follow this biocultural approach to studying palaeopathology, others find it inappropriate for British material.

The infectious diseases cover a wide range of conditions affecting both soft tissue (e.g. plague, cholera, malaria) and the skeleton. While those infections which involve soft tissue will not be observed in the skeletal record (even though they may be studied in other ways, e.g. a palaeodemographic study of a plague cemetery,[1] and identification of the plague bacillus using ancient DNA[2]), in many infectious diseases only a small percentage of people will have skeletal involvement (e.g. 3–5% in tuberculosis[3]), and some people may have died before bone changes occurred, i.e. in the acute phase of the disease. It should also be noted that healed lesions represent chronicity and a healthy immune system that prevented the individual succumbing from the disease in the acute stage.[4] In many respects the study of infections in antiquity potentially provides a window on how humans have evolved and adapted to, or changed, their environment. As suggested,[5] 'infectious diseases have played a major role in the evolution of the human species . . . a prime mover in cultural transformation, as societies have responded to the social, economic, political, and psychological disruption engendered by acute epidemics . . . and chronic debilitating infectious diseases'

(p. 31). They are, therefore, a fascinating area of research in anthropology as a whole and need considering from a multidisciplinary perspective.

A range of pathogenic organisms consisting mainly of viruses, bacteria, fungi and parasites cause infections. Of course, whether a person is vulnerable to an infectious disease depends on many intrinsic and extrinsic factors. Pathogenicity of the agent, route of transmission, nature and strength of host response,[5] age, sex, genetic predisposition, nutritional status (there is a relationship between quality of diet and infection), occupation, trade and contact, climate, population density, economy, sanitation, quality of housing, and many more factors must be considered when interpreting the evidence for infectious disease in the past. However, much of the information needed to complete this jigsaw will not be available to the biological anthropologist because of the fragmentary nature of the data we deal with. Today, infectious disease remains *the* major cause of death worldwide and causes much ill health and misery in human populations.[6] Thus, it deems itself an important area of study in anthropology as a whole. By studying how infectious diseases have evolved, and the factors inherent in their appearance, transmission and maintenance in a population, they may help shed light on the epidemiology of infectious disease today.

This chapter will concentrate on those infections that affect the bones of the skeleton and have been recorded most commonly in skeletal material worldwide. These infections may be classified as specific (known causative organism) and non-specific (could be caused by a variety of organisms). Infections are usually associated with inflammation, or a cellular reaction to the invading organism, manifested as pain, swelling, tenderness and raised temperature.[7] In antiquity the infections evident in the skeletal record were more often caused by bacteria rather than viruses, as the latter would have been more rapidly overcome (or proved fatal), leaving no bone change. However, there are potential avenues for identifying viral infections that have been noted in the published literature. For example, smallpox can leave osteomyelitic and arthritic variolosa lesions, usually in the elbow joint,[8] and a possible example of these changes has been reported in the archaeological record.[9] Furthermore, poliomyelitis may be identified in the skeleton in the form of atrophy and osteoporosis of limb bones as a result of paralysis.[7] Finally, Paget's disease of bone, despite being of unknown specific aetiology, is suspected to be the result of a slow viral infection.[8] Although the bone changes of formation and/or destruction, *per se*, of non-specific and specific infections are the same, it is their distribution pattern which is characteristic in diagnosing the specific infections.

Many books, chapters, and major review articles have been published on the infectious diseases in antiquity.[7-18] These range in content from historical documentation, through diagnostic texts, to interpretative bioculturally focused discussions of data.

The infections most commonly reported and analysed in the palaeopathological literature are the non-specific infections affecting the periosteum (periostitis), cortex (osteitis) and medullary cavity (osteomyelitis) of bone. These changes, however, can also be seen as manifestations of a specific infection (but in a specific distribution pattern), or be focused on a particular part of the body. Leprosy, tuberculosis and treponemal disease are those specific infections reported most frequently (the fungal infections, seen in North

America have not yet been reported in British material and therefore are not considered here). However, focal non-specific infections in the sinuses (maxillary sinusitis), meninges (meningitis), ears (mastoiditis, otitis media), and lungs (affecting ribs) have seen increasing interest in biological anthropology in recent years, particularly in Britain. Non-specific periostitis, osteitis and osteomyelitis, however, may occur anywhere on the body, and periostitis (especially of the tibial shafts) has been the focus of much work in the palaeopathology of indicators of stress.[19]

Studies of infectious disease in past human skeletal populations have focused on a number of areas, all of which have, and still can, contribute in different ways to the palaeoepidemiology of infections. Much work has been undertaken on developing diagnostic criteria (particularly for the specific infections) which, in itself, is essential and the starting point for identification of infections in skeletal remains. Moreover, it has highlighted some problems in the clinically based diagnostic approach where diagnostic criteria from clinical sources may not always be appropriate for archaeological material. Case studies of specified infectious diseases, while not contributing to the advocated 'biocultural population approach' *per se*, do (when collated) add to the picture, i.e. without them there would be less data. However, the population-based biocultural approach is the one currently advocated. This enables the biological data to be linked meaningfully with cultural data and the data produced to have a more significant role in the reconstruction of past human evolution and adaptation. This approach inevitably considers ecological factors in the appearance and maintenance of infections in a population,[20] for example the impact of urban and rural environments on infectious disease and the change in frequency in infectious disease in hunter-gatherer as opposed to agricultural communities. The origin, evolution and spread of infectious disease worldwide, as a study in its own right, has been enabled by the production of data, while hypotheses about infectious disease have been raised on the basis of evidence reported. All these approaches are valid in the British context, although some areas have not been tackled using British data.

NON-SPECIFIC INFECTION

Non-specific infection appears to consistently increase in frequency with the transition to agriculture in many populations around the world.[21] The increase in population size and density, settled and permanent housing, poor sanitation, changes in nutrition, and increase in trade and contact are believed to have lead to an increase in susceptibility to infection. In addition, the development of urbanization and industrialization worldwide has contributed to increased rates of infectious disease. In British contexts it has not been possible to assess health at the transition to agriculture due to the lack of skeletal material available for study from pre-agricultural contexts. However, much skeletal material exists from specific contexts, which could be used for looking generally at infectious disease prevalence. Although a population study of sex differences in infectious disease (maxillary sinusitis) in urban and rural contexts has recently been undertaken,[22,23] urban infections, particularly in British medieval contexts, have rarely been a focus of interest (with some exceptions[24–26]). This is particularly surprising considering the wealth of contemporary historical data available for study and interpretation. Non-specific infection is recorded as case studies[27,28] and is routinely reported in the archaeological literature in British contexts in the form of periostitis, usually on the tibiae and fibulae, and osteitis and osteomyelitis (although the latter two tend to merge and are often both classed as osteomyelitis). Of course, other areas of the skeleton can also be involved especially when the changes are the result of a specific infection. However, periostitis can also be an indicator of other conditions that must all be considered in a differential diagnosis, e.g. trauma. The differential diagnosis of the infectious diseases has also been discussed from a British perspective.[29]

Data in Britain are generally presented as individuals affected rather than actual prevalence rates (both should be given). Few people have taken the data further than this, with some exceptions where non-specific infection has been considered along with other 'indicators of stress'. For example, in one study[30] nearly 60% of subadult individuals suffered long bone periostitis in both urban and rural populations. In North America this information is routinely recorded for archaeologically derived skeletal material (for examples, see [21]), and the way forward is to acquire prevalence rates for this condition for British material. In addition, recording of the nature of the bone formed as a response to inflammation (i.e. woven or lamellar, denoting active or healed), its distribution pattern and prevalence rate, may help in some way to assess its aetiology. Of course, periostitis may be the result of trauma and, more specifically, has been reported as an indicator of child abuse,[31] and could be part of injury patterning in torture victims.[32] Whatever its aetiology, it does tend to occur more frequently on the tibiae, which, because of their extensive vascularity and physiologically inactive surfaces, slower blood circulation, and lack of soft tissue covering, are most vulnerable to develop bone changes of infection from colonization of the area with bacteria.[15] A point to note, although it is problematic to distinguish, is that in very young individuals, periosteal new bone formation should not be mistaken for new bone as a result of normal growth. In addition, there have been several instances where normal porosity on certain bone elements (e.g. the brow ridges and zygomatic bones of the skull) have been mistaken for periostitis.

A survey of published and unpublished data from British contexts reveals some problems. The first point to make is that, as there is no standard format for skeletal reports, non-specific infection tends to be assigned either to the infectious disease category or nutritional/metabolic disease, the former being preferred. Second, a common trend noted is the reporting of prevalence rates for non-specific infection by individuals affected and not as an absolute rate of bones affected compared with bones present,[33,34] with some exceptions.[35–39] No non-specific infection is reported for the post-medieval sample from Christ Church, Spitalfields, London,[40] which is surprising considering the historical evidence suggesting environmental factors predisposing to infection. In some instances specific individual skeletons are described in detail but no specific prevalence rates given.[41] While *individual* prevalence rates are essential for interpretation, this assumes that all bones for all individuals were present for observation (not the case for archaeological material). For example, if many skeletons are missing their lower leg bones then the most frequently affected bones in non-specific infection cannot be recorded and therefore the *actual* prevalence rate may be incorrect. *Actual* bone prevalence rates are also required to enable any meaningful interpretations and/or comparisons with populations both geographically and temporally. Valid and useful recommendations on the study of non-specific infection have been made,[19] which included narrowing down age ranges for individuals affected (which, for adults, is problematic considering the inaccuracy of ageing methods), distinguishing degree of severity, exact location and evidence of healing, considering factors associated with infection, nutrition and culture, age and sex differences, and integrating the data with other stress indicators.

When dealing with specific parts of the body with respect to non-specific infection (rib involvement is reserved for the section on tuberculosis), involvement of the maxillary sinuses is sometimes mentioned,[37,42,43] and infection of the ears,[43,44] but on an individual basis and not as a true prevalence rate. Population studies of these conditions are rare. In addition, there is increasing work considering changes on the endocranial surface of the skull which may be consistent with meningitis, or inflammation of the meninges.[45] In fact, a case of pituitary dwarfism in a 4th-century AD British context showing bone formation endocranially was suggested to be the result of tuberculous meningitis, a common cause of damage to the pituitary gland.[46] There is debate, however, about whether a person in the past could have survived long enough with meningitis for bone change to occur; changes in virulence of the causative organism (i.e. an increase in virulence through time) may be one explanation. Recent work on ear infection[47,48] has indicated respectively that of 136 ear bones examined from 471 temporal bones, 51% had erosive lesions indicating infection, and of 1244 temporal bones representing 688 individuals from seven Roman to late medieval cemeteries, there were similar infection rates to modern figures. In addition, preliminary studies on the evidence for maxillary sinusitis, although previously higher in Anglo-Saxon individuals (6.8% of individuals examined[49]) compared with earlier and later groups, have shown higher rates in urban compared with rural populations (55%:39% respectively[22]), and high frequencies in individuals from a medieval leprosy hospital.[50] As these conditions are common in modern populations (e.g. middle ear infection[51]), it would be recommended that they are recorded for archaeological material using protocols already developed,[48,50] and considered with respect to age and sex differences. It should be noted, however, that elsewhere in the world it is periostitis/osteomyelitis of long bones, which are usually recorded, and not infections of the ears or sinuses, save for a few exceptions.[52-57]

SPECIFIC INFECTIONS

The most common specific infections reported in the palaeopathological literature[7,17,18] are leprosy, tuberculosis and treponemal disease which all have bone changes which overlap in nature with each other (e.g. facial changes).[58] It is therefore particularly important to consider the characteristics and distribution pattern of lesions in the skeleton to ensure an attempt at an accurate diagnosis. All these infectious diseases have increased through time until factors such as developments in chemotherapy and improvement in living conditions decreased their frequency (e.g. tuberculosis[59]); however, in some areas of the world these infections are still prevalent and are increasing. They have a fascinating history, which has been revealed both by historical and skeletal evidence worldwide. In Britain and the rest of Europe, along with the skeletal evidence we are also fortunate to be furnished with a wealth of contemporary historical documentation, especially in the medieval and later periods. However, the trend in palaeopathology has been on case studies, and theoretical approaches to the origin, development and transmission of these infections, with very little attention paid to looking at real prevalence rates in populations through time and throughout the world, especially in Britain. In British contexts, however, some researchers have figured very prominently in developing diagnostic criteria for identification of these infections in skeletal remains.

Leprosy

An infection cause by *Mycobacterium leprae*, leprosy is contracted via the pulmonary route through droplet infection, and possibly via skin to skin contact.[8] It is predominantly found today in the southern hemisphere, but in the past the northern hemisphere appears to have harboured the majority of cases, particularly in northern Europe, and leprosy was not introduced into the New World until European contact in the 15th century AD.[15] The clinical expression of leprosy is very much determined by the individual's immune response and, for palaeopathological purposes, if the person is highly resistant to the infection he or she may not develop any bony involvement, thus precluding diagnosis in an archaeological context. Britain figures very prominently in the history of this disease, which makes its study in skeletal remains particularly important. Although much of the history of leprosy is documented (not always reliably) in written texts[60] and illustrated in iconography,[61] the primary evidence for the infection can only be considered from skeletal remains.

Although the first written evidence of leprosy comes from India and is dated to about 600 BC,[7] the first evidence from human remains is dated to the 2nd century BC,[62] and in Britain to the 4th century AD,[63] although there is some dispute about the diagnosis of this case.[34] However, and this is mirrored in many other European countries, from AD 1000 to 1600 over 200 leprosy hospitals were founded in Britain, mainly in England,[64] suggesting that the disease was prevalent (although this cannot be taken *per se* as an indication of the disease frequency). Increasing population density, poverty, increase in trade and contact, and nutritional stress may all have contributed to its rise in prevalence. Historical sources indicate that people with leprosy were stigmatized and, once diagnosed, banished into the local leprosy hospital, an event not infrequent today in many parts of the world.[65] However, it is very probable that many were not diagnosed and others were misdiagnosed,[66] which probably explains why leprous skeletons are found not only in leprosy hospital cemeteries, but also in non-leprosy hospital graveyards, something to remember when considering the skeletal evidence.

The key figure in highlighting the bone changes of leprosy in archaeological contexts was Moller-Christensen when he excavated and analysed the Danish leprosy hospital cemeteries,[67–68] but British research, in particular, has refined the diagnostic criteria for leprosy by developing these initial findings.[70–74] Diagnosed cases of leprosy have mainly come from Denmark[67–69] and England,[75–81] although evidence for leprosy in Western Micronesia,[82] Israel,[83] Hungary[84] and France[85] has been reported. Apart from the Danish, and English work (on the medieval leprosy hospital from Chichester, Sussex), no collective studies anywhere in the world have been undertaken charting the development and frequency of the disease (incorporating unpublished work), the age and sex distribution of leprous sufferers, and their status. Considering the wealth of historical documentation available on the antiquity of leprosy, including its social aspects and how it was diagnosed and treated, and the confidence in diagnosing this infection in skeletal remains, it is surprising that this has not yet been attempted, especially in Britain.

Tuberculosis

Tuberculosis in humans is caused by the two organisms, *Mycobacterium tuberculosis* (via droplet infection from human to human) and *M. bovis* (via ingested meat and milk from animals, particularly cattle, or via droplet infection). It is becoming an increasing problem today worldwide,[86] especially drug-resistant disease in people of low socio-economic status with HIV and AIDS, and it has been termed a disease of poverty. Only a few per cent of people with tuberculosis will develop skeletal changes and therefore its identification in skeletal material may be expected to be rare. Primarily the spine, hip and knee joints are those parts of the body most affected,[18] but work suggesting that periostitis on visceral rib surfaces (Figure 1) may indicate pulmonary infection (most likely tuberculosis) is gaining more support.[87,88] The study of tuberculosis in human populations is particularly important because of its strong link with tuberculosis in animals,[89] particularly cattle, and the suggestion that it developed in humans with the advent of domestication. Not only is more work needed in tracing the appearance, development and prevalence of this infection in antiquity in humans, but also in non-humans in the past, something which, until recently,[90] has been neglected in archaeozoological studies worldwide. Interestingly, it is tuberculosis upon which most diagnosis of disease using ancient DNA[91,92] and mycolic acids[93] has been focused.

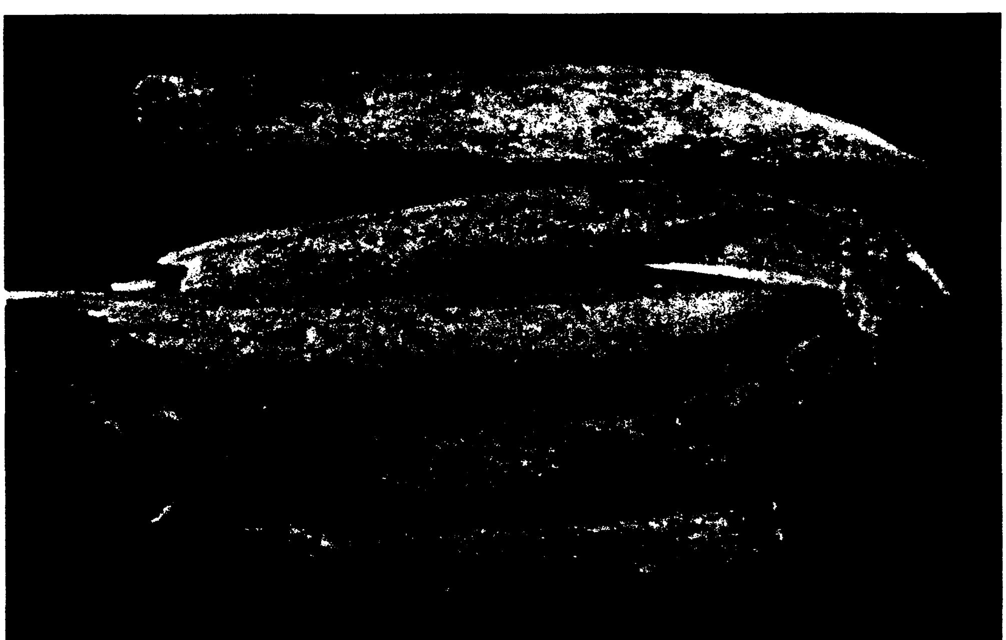

Figure 1 – Periosteal new bone formation on the visceral surfaces of ribs (Romano-British).

Written and artistic representation of tuberculosis is somewhat problematic to interpret as the signs and symptoms of pulmonary tuberculosis are similar to a whole range of other lung complaints. Also, the hunchback deformity depicted in many paintings, sculptures and reliefs could be purely artistic license and/or represent other diseases affecting the spine. Palaeopathological evidence of tuberculosis is found worldwide; in the Old World, cases are reported as early as the 4th millennium BC from Italy,[94,95] and in the pre-Columbian New World as early as AD 700 in South America.[96,97] Tuberculosis is a population density dependent disease and with increasing urbanization, poverty and malnutrition, and close contact with animals and their products, its prevalence in the past would have been affected by these contributory factors. Again, Britain was witness to large numbers of tuberculosis sufferers, particularly in the later medieval and post-medieval periods. For example, 'Touching for the King's Evil' (tuberculosis) was practised on thousands of victims as a cure, and in the 17th century in London 20% of all deaths were reported to be due to tuberculosis.[7] Of course, like leprosy, historical documentation of the disease cannot, *per se*, be taken as indicative of the actual prevalence of tuberculosis, but may be regarded as an indication of the problem at the time.

Diagnosed cases of tuberculosis have come from a variety of countries in the Old and New Worlds, e.g. Japan[98], Egypt[99] and Jordan[100] but remain basic case reports with no collation of data looking at the frequency of tuberculosis. In Britain the first evidence for tuberculosis is dated to the 4th century AD,[33,101] but cases have been reported through into the post-medieval period[102] and increase particularly in the later medieval period, as seen in both skeletal[102] and historical evidence.[103,104] The decline in leprosy around the 14th century AD may reflect the cross immunity between leprosy and tuberculosis.[105] There are, however, other suggestions for the decline of leprosy at this time, and mortality due to the plague is highlighted.[106] The idea that sufferers of leprosy were not resistant to the plague bacillus and could not escape its ravages is not as compelling an argument as tuberculosis cross immunity causing the decline. It has been suggested that the leprous were no more vulnerable than the poor in general.[60] Other suggestions for leprosy disappearing include a drop in mean annual temperature, eating fish and drinking goat's milk, and segregation of the affected.[64]

Because the numbers of tuberculous individuals diagnosed in British contexts have been low,[102] it has been suggested that the criteria being used may not be wholly adequate.[7] In addition, there are many individuals in the British skeletal record with occurrence of periostitis on ribs,[102] and evidence to support the theory that tuberculosis induces these changes is increasing.[107] If these lesions are accepted as tuberculous induced, then the clinical diagnostic criteria for tuberculosis may be deemed, for biological anthropologists, partially inadequate. Based on the currently accepted diagnostic criteria described[7] what is now needed is collation of data on the actual prevalence of skeletal tuberculosis through time in Britain, and a correlation of these data with culturally relevant information. In addition, a consideration of the frequency of periostitis on rib surfaces as a possible indicator of pulmonary tuberculosis must be made to enable more realistic figures for tuberculosis to be produced. Finally, studying the relationship between human and non-human tuberculosis in archaeological contexts would help clarify information on the appearance, development and maintenance of tuberculosis throughout the world over long periods.

Treponemal disease

The bacterial infection treponemal disease covers four syndromes that can potentially affect humans, although one (pinta) does not affect the skeleton and is therefore invisible with respect to palaeopathological studies. Endemic syphilis (or treponarid/bejel), yaws and venereal syphilis all affect bone and are caused by spirochetes of the genus *Treponema*. All these syndromes are associated with specific regions, climates, and socio-cultural factors,[108] i.e. pinta: tropical regions of America, yaws: hot tropical humid areas, bejel: temperate and subtropical arid regions, especially the Middle East, and venereal syphilis: ubiquitous around the world in urban environments today. They are transmitted via skin to skin contact through open lesions, and venereally in the case of venereal syphilis. It is believed that 'every human population has the kind of treponematosis that is adapted to its physical environment and socio-cultural status' (p. 155).[8] The current (and long-standing) historical question which is still being debated is where did venereal syphilis originate, in the Old or New World.[109–113] The current answer, based on the evidence to date, is that it was present in both the Old and New Worlds before Columbus made his journey to the New World. However, the abundant evidence in the New World does tend to overshadow the more limited data from Europe. This was recently reviewed in a symposium at the Annual Meeting of the American Association of Physical Anthropologists, which considered a series of systematic critical evaluations of treponemal disease in ten regions of North America.[114]

All the syndromes affecting the skeleton produce similar bone changes, which consist of periostitis, osteitis and osteomyelitis. In yaws the tibia is most affected but the nasal area of the skull may be destroyed. In endemic syphilis the cranium is rarely involved (as in yaws) but the naso-palatal area can be, Again, the tibia is the most affected bone, resulting in the sabre shin shape due to new bone apposition anteriorly.[7] In venereal syphilis the frontal bone of the skull (caries sicca lesions) and nasal area, plus long bones (particularly tibia), are the most frequently observed bones affected. In addition the joints may be destroyed in the tertiary phase (Charcot joint). Venereal syphilis can, of course, pass to an unborn child from an infected mother via the placenta and give rise to congenital syphilis, manifest mainly in the tibiae and dentition (mulberry and moon molars and Hutchinson's incisors occur in 30% of children with congenital syphilis[15]).

Based on diagnostic criteria developed by Hackett,[115] palaeopathological evidence of published treponemal disease is found worldwide in the form of collective works,[109,111] but also as case studies,[116,117] In Britain the (scarce) evidence for treponematosis dates from the late medieval period and has been summarized.[118] However, it is the author's opinion that some of the cases diagnosed in New World contexts on the basis of periostitis/osteomyelitis may benefit from being re-evaluated (e.g. [119]). Recording these changes as indicative of treponemal disease may be a diagnosis for another disease causing the same changes, and therefore only recording cranial and facial involvement as treponemally induced may be the most accurate way of recording true prevalence rates (there has been a tendency in Old World contexts to do the latter).

The treponematoses clearly need specific environmental (often rural) conditions, poor sanitation, and lack of clothing for survival and maintenance, but for venereal syphilis to make an impact on a population there are usually higher levels of sanitation and the infection increases rapidly in urban situations[15] where trade and contact between people occurs more readily. Although few cases so far have been reported in British contexts, biological anthropologists should make accurate identification of cases one of the highest priorities because of the numerous hypotheses and questions which have been raised over the years about the treponematoses. Britain plays a large part in the debate and could contribute more.

CONCLUSION

This review of infectious disease in British palaeopathology has, necessarily, been summarized. It is clear that there is still a lot to achieve, but achievements are possible with the skeletal material available. Basic training in identification of these conditions and then following the recommendations outlined below should, even minimally, provide some sound data from which to develop ideas about the infections in Britain. However, there is a need to isolate the gaps we have in knowledge by reviewing the work already undertaken on skeletal material from British contexts. When those gaps (which are many) have been identified, it will then be possible to raise hypotheses about infectious disease. In addition, these gaps should be discussed with the archaeological community so that current issues in our discipline are known, and future cemetery excavations may help to test these hypotheses. However, before those hypotheses can be tested, accurate, detailed descriptions of pathological lesions using standard terminology, stating whether lesions are active or healed are needed (Figures 2–4). It is inevitable that macroscopic and radiographic methods of examination will be used primarily for analysis and could be limited in some respects, but physical, biological, and chemical analytical techniques may help in disease diagnosis in problematic circumstances, or when a specific question cannot be answered using basic analytical methods. Clinically based diagnostic criteria, with consideration of differential diagnoses, are the pre-requisite for any work in the infectious diseases (and in palaeopathology as a whole). Particular problems to note with reference to recording of infections are, in leprosy, survival of the hand and foot bones, which is a problem as they are often missing from the archaeological record and are affected in leprosy. In addition, in leprosy, tuberculosis, and treponemal disease, the facial damage (Figures 5 and 6) can be very similar and potentially confusing, which emphasizes the need to consider accurate description and the distribution pattern of pathological alteration of the skeleton. In tuberculosis there are many differential diagnoses for the spinal changes, and the periostitis of ribs at this stage can only be considered as a non-specific response to infection. Finally, in treponemal disease and leprosy, the non-specific infective changes of the lower legs may be part of both those disease processes but could occur in other conditions.

It is recommended that both prevalence rates for individuals in a population, and prevalence rates for numbers of elements observed, should be presented, and by sex and age at death. All data should also be considered within its cultural context e.g. is it a rural or urban site, and what might the impact of these environments be on infection? In addition, period of site, geographic region, and funerary context are important, as is a consideration of sample representativeness. Probably one of the most interesting outcomes of any palaeopathological study is the interpretation of the evidence in relation to lifestyle, which may include stigma

Figure 2 – Woven (active) new bone formation on the endocranial surface of the occipital bone (Anglo-Saxon).

Figure 3 – New bone formation (lamellar) on a long bone (healed).

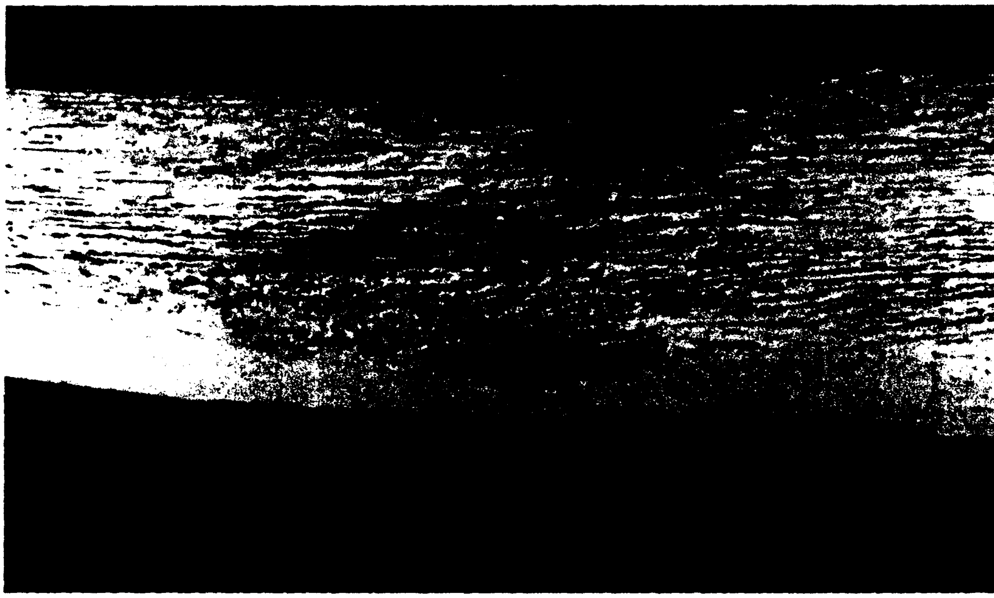

Figure 4 – New bone formation on long bone (mixed woven and lamellar bone).

Figure 5 – Damage to the nasal and frontal bone areas of the skull in an individual suffering from treponematosis (later medieval).

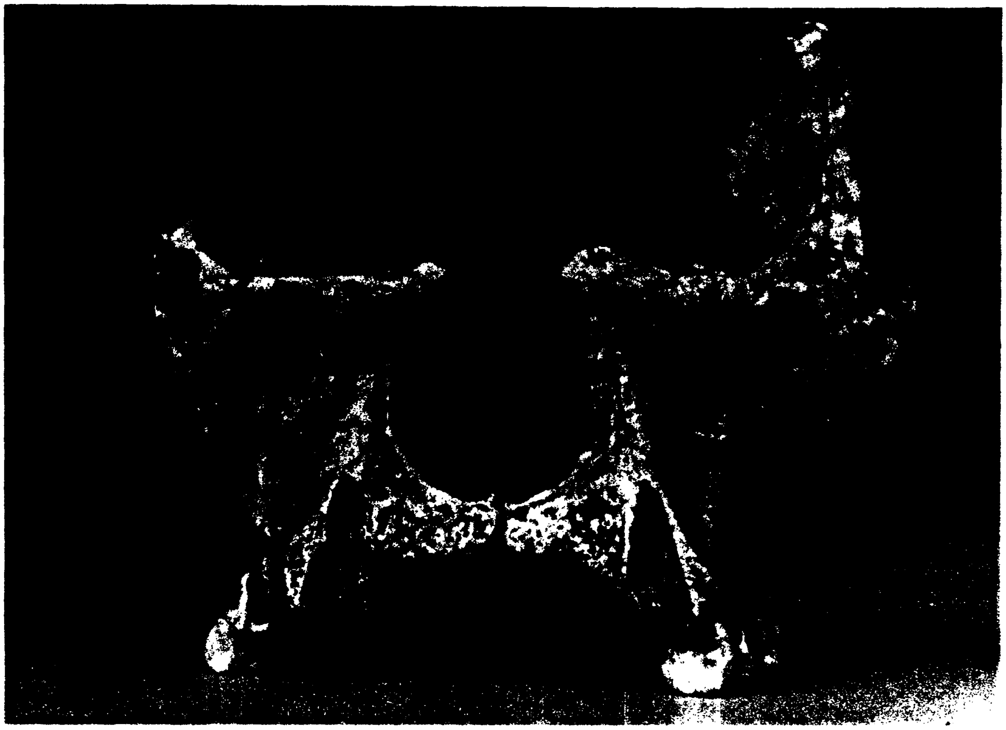

Figure 6 – Maxilla with damage to the alveolar bone suggesting leprosy (later medieval).

and disability in leprosy, for example. As previously outlined, the lack of published, population-based studies in Britain means that there is little data to work with at present but, in addition to advocating further population studies, the collation and review of reported case studies of infectious disease would be extremely useful. Once data has been collected and analysed in the manner suggested we can then start to compare our data with that of other countries to gain a population based assessment of the development and spread of the infections in antiquity, and how humans have (successfully or unsuccessfully) adapted to them.

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21

TRAUMA IN BIOCULTURAL PERSPECTIVE: PAST, PRESENT AND FUTURE WORK IN BRITAIN

Charlotte Roberts

INTRODUCTION

'Investigation of injury morbidity and mortality facilitates the assessment of environmental, cultural and social influences on behavior' (p. 9).[1] The aims of this chapter are to review the types of information that are potentially retrievable from a study of trauma in antiquity, and summarize the range of published research already extant on trauma. Further, it seeks to document the range and quality of work already completed on British material, and to recommend the way forward and best practice. It will not be possible to include all aspects of trauma but the more common approaches will be considered. Emphasis is placed on the study of both biological (skeletal) evidence for trauma, and the cultural context from which it is derived (i.e. the biocultural approach).

A holistic approach to studying any health problem is recommended, i.e. consideration of multiple forms of evidence to reconstruct health and disease patterning. While much of the emphasis in the study of trauma in British contexts has been on individual case studies, in North America the 'population-based biocultural approach' has been developed. If palaeopathological study in Britain is to advance, this latter approach is recommended.

BACKGROUND

Trauma can be defined as any bodily injury or wound, and it may affect bone, soft tissue, or both.[2] Fractures are the result of any traumatic event that leads to a complete or partial break in the continuity of bone. Trauma covers many different areas and, as such, is commonly seen in archaeologically derived human skeletal material along with joint and dental disease. Of course, trauma may also affect only the soft tissues and will not, therefore, necessarily be observed in the skeleton. In addition, traumatic lesions may be so long-standing that the evidence could have been remodelled away before the person died, e.g. a fracture in childhood may be invisible by adulthood.

Trauma is regularly reported in skeletal material and can potentially provide data on a variety of aspects of past population behaviour. Some areas to be considered include domestic accidents (which may reflect physical environment and, for example, the climate), interpersonal violence (which may reflect sedentism, competition for resources, social inequalities and complexity, and increased trade and contact), and occupationally related trauma (e.g. environments and their effects on lifestyle). In addition, subsistence strategy (hunter-gathering versus agriculture), male and female differences, availability of treatment and nutritional status at the time of the fracture and throughout the healing phase (indicated by the end result of the healing process), are also areas of potential study with respect to occurrence and patterning of trauma. While, in general, the vast majority of work in palaeopathology has concentrated on injuries resulting from interpersonal violence, there is also research published on less dramatic lesions.

Trauma can be classified into four categories:[3] a partial or complete break in a bone (fracture), abnormal displacement or dislocation of a bone, disruption of nerve or blood supply (which may be a complication of a fracture), and artificially induced abnormal shape or contour (e.g. artificial deformation of the head). For the purposes of this chapter fractures and dislocations to the post-cranial skeleton will be considered, as the majority of injuries to the head and neck region are due to intra- and intergroup violence rather than accidental injury, and are covered elsewhere (see Boylston, chapter 22, in this volume). In addition, the evidence for trauma in the form of amputation and trepanation will be considered, as well as the treatment of post-cranial fractures; decapitation, scalping, weapon and soft tissue injuries, cannibalism and dental trauma are beyond the scope here.

PREVIOUS WORK

Many excellent books, chapters, and major review articles have been written on trauma in antiquity,[1–8] their content ranging from very clinically based diagnostic approaches, to bioculturally interpretative considerations. Perhaps most work published in trauma has tended to consist of the 'case study',[9,10] or focus on trauma to particular parts of the body.[11] While interesting in themselves, they do not necessarily contribute to reconstructions of trauma patterning through time, although collectively considered they are helpful. Rarely have researchers dealt with issues of gender, status or economic, geographic or chronological differences in trauma patterns on a large scale (although see Cohen and Armelagos[12] on hunter-gatherer/agricultural differences, see Grimm[13] on gender differences, and see Angel[14] on chronological change in Greece). Other papers have contributed studies on developing a methodology for recording fractures in archaeological material,[2,15–18] while some have concentrated on treatment of trauma.[17,19–22] There is a lack of population studies of trauma patterning and prevalence, although over the past few years more have been published,[1,15,16,23–25] which describe very useful bioculturally relevant population studies. While trauma is common and easily recognizable in the archaeological record, and can potentially inform us of many aspects of past human behaviour, this potential has sadly not been exploited fully in published literature worldwide. As has been stated, 'The sparseness of a population perspective in this literature, however, precludes the realisation of the enormous potential that these kinds of data have for drawing inferences about human behaviour and conflict in earlier societies'[1] (p. 109).

FRACTURES: A GUIDE

There is a considerable literature reviewing this subject.[26–29] Acute injury, repeated stress or an underlying weakness (e.g. osteoporosis in the spine) may induce fractures, but it is acute injury that constitutes the major cause. In addition, fractures may be closed (simple) or open (compound). Compound fractures mean that the fractured bone is exposed to microorganisms infiltrating the fracture site and causing infection, an obvious danger in antiquity without the availability of antibiotics for treatment. In addition, there are many types of fractures that are caused by varying forces. Some are named after the person who originally described them, some are named after occupations that commonly cause them, some names reflect the anatomical part affected, and some indicate the causative force.[6] For example, oblique and spiral fractures are caused by indirect/torsional forces, and transverse fractures by direct force. Comminuted (in many pieces) fractures tend to be associated today with high-impact road traffic accidents, greenstick fractures are seen in young individuals where the bones are malleable and do not break completely, and an impacted fracture results when the two fractured ends are driven into each other. Traction/avulsion fractures are when a fragment of bone is detached due to a sudden contraction of a muscle associated with a bone, and a compression fracture (usually in a vertebra) is the result of compression forces running through the bone(s). These fracture types have been illustrated previously,[7] but a particular problem to note with compression fractures in the spine is their differential diagnoses (Figures 1–3). Specific causes of fractures in archaeological contexts may be hard to identify. However, it is known that particular fractures occur more commonly in some circumstances, for example falls on an outstretched hand often lead to Colles' fractures of the wrist, i.e. an acute injury.

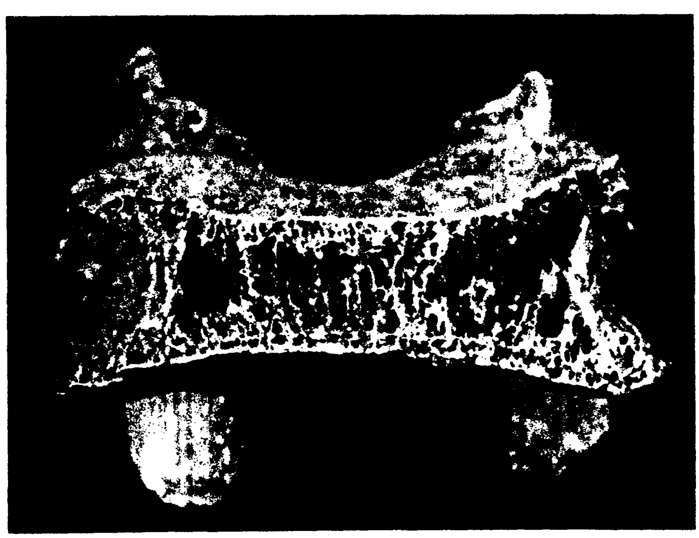

Figure 1 – Osteoporosis underlying a vertebral compression fracture (Romano-British).

Figure 2 – Compression fractures in vertebral bodies as a result of trauma – no underlying pathology (Romano-British).

In archaeological contexts fractures observed are usually healed, indicating that the bone has undergone the first two stages of the healing process (circulatory/cellular and metabolic) and is into the final (and longest) mechanical phase. In this phase the bone (or bone cells, osteoblasts and osteoclasts) is gradually remodelled back to its normal anatomical shape. There are, naturally, many factors that affect the rate and efficiency of healing, and these include the fracture type and the bone affected. For example, arm fractures heal faster than leg fractures in clinical contexts but it should be remembered that availability of treatment will have an effect on this, for example forearm fractures often need internal fixation, something not readily available in the past. Other factors that may affect the healing process are the age of the person (the young heal faster than the old), whether the fracture has been treated, the presence of infection or other disease, the blood supply to the affected part and the person's diet. Some of these factors may be identifiable in skeletal material or known about the sample under study, but some will not, yet all must be considered with respect to fractures in past human groups. Of course, complications of fractures are many and some have been recorded in archaeological contexts (e.g. non-union[30]). In clinical contexts, infection, shortening and/or angulation of a limb due to a poorly reduced fracture (with or

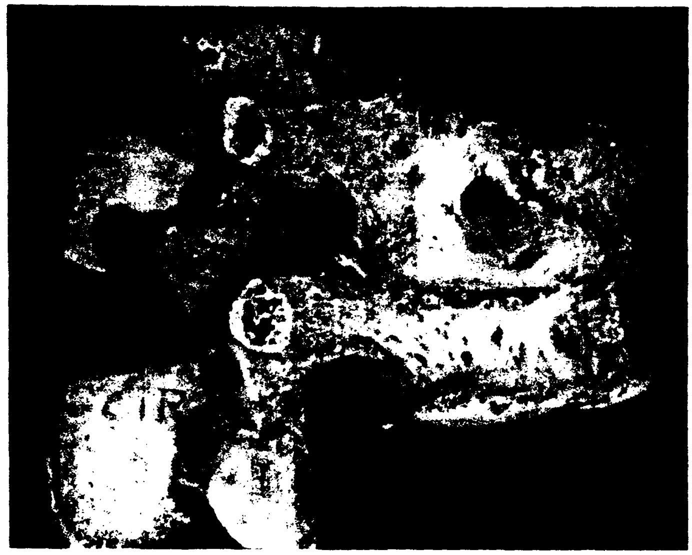

Figure 3 – Compression fractures of lumbar vertebrae due to underlying infection (Romano-British).

without associated osteoarthritis of adjacent joints), death of bone due to severing of blood supply, blood vessel or nerve damage, pseudoarthrosis, and myositis ossificans (ossification of damaged muscle tissue) are the most common. In archaeological contexts there has only rarely been systematic documentation of fracture complications.

In clinical contexts trauma is well documented, and it is from there that information on types of fractures, their causes, complications and healing rates is usually accessed by people working on the palaeopathology of trauma.[26-29,31-33] It is generally easy to apply the principles for studying fractures in modern populations to the dead, although the factors inherent in the aetiology of fractures have changed through time so care must be taken in using some of these data. For example, comparative data from traditional agricultural communities with no access to modern technology do exist and have been used, and these are more appropriate for archaeologically based studies.[34] Furthermore, there is an equal or greater number of papers covering a range of areas in modern fracture studies that can be used as comparative data,[35] although with modern studies the whole patient is being observed and not just fragments (as in an archaeological context).

STUDIES OF TRAUMA IN ARCHAEOLOGICALLY DERIVED SKELETAL MATERIAL

Archaeological studies of trauma range from the case study to the biocultural approach to fracture patterning. For example, individual case studies have been used to investigate prevalence rates of fractures from the 7th millennium BC to the 2nd century AD in Greece.[14] However, population based studies of chronological trends in fractures are rare. A different approach, looking in detail at fractures in a particular sample, was undertaken on skeletal material from Ohio, North America[36] and, although focusing on one medieval population in England, a comparative study of fracture patterns with five other sites of the same period has also been made.[15] A recent issue of a journal in the field, although dealing with issues of trauma in archaeologically derived human remains, was somewhat disappointing in that most papers failed to deliver a truly biocultural approach to trauma patterning, with real fracture prevalence rates.[37]

A survey of trauma reported in published and unpublished skeletal reports from Britain also displays a disappointing amount of useful data; many reports do not describe trauma by actual prevalence rate. It indicates that there are three classes of trauma data in skeletal reports. Some describe fractures by individuals affected with no bone counts available to determine *actual* prevalence rate[38–44] (this assumes all bones for all people were available for examination). Others describe fractures by individuals *and* by bones affected, with[45,46] or without[47] bone counts. Finally, some provide data on individuals affected and bones affected but do not discuss *actual* prevalence rates for each bone, although bone counts are available (i.e. the reader can calculate this using the data provided).[48–52] There clearly needs to be greater consistency in reporting.

Special fractures include the clay shoveller's fracture of the seventh cervical and first thoracic vertebrae, and spondylolysis (detachment of the neural arch at the pars interarticularis), usually of the fifth lumbar vertebra.[53] The latter is more commonly reported than the former, although both are seen in British material.[54,55] Both conditions may be directly related to activity (stress and strain) and need more study. In addition, attention has recently been drawn to the skeletal evidence for child abuse in the form of both fractures at specific sites in the body and periosteal new bone formation on certain bones of the skeleton.[56] Child abuse, and also torture (described in the forensic literature as consisting of mainly soft tissue injuries and possible amputation of parts such as fingers[57]) are frequently described in the media today but are rarely considered in the past. Having so much modern data on these two aspects of human behaviour means that a study in the past potentially has some comparative base, and this is another area that could be considered with respect to British archaeologically derived skeletal material.

Some other traumatically induced conditions reported very occasionally in British material include slipped femoral epiphysis,[58] and dislocation.[59] Similar conditions are also reported from outside Britain.[60–62] The loss of contact between two bones at a joint (dislocation), usually of the hip or the shoulder (which may be either congenitally, traumatically or disease induced) is recognizable only if the bones stay out of alignment for long enough for another joint surface to be created, or if characteristic fractures in peri-articular bone are present,[29] or other related lesions.[63] It is possible, as today, that some dislocations may have eventually naturally reduced themselves.[7]

TREATMENT OF TRAUMA

Arising from a study of trauma is the question of whether, and how, people in the past cared for those who suffered trauma. Trauma, like any other health problem (as today), may have prevented a person from functioning 'normally' within their community. Therefore, care and treatment are likely to have been sought, and communities would have gradually developed care systems. The abundant evidence for beliefs and concepts of disease, diagnosis of disease, anatomical knowledge and its relevance to treatment, and treatment in a general sense in past and contemporary traditional societies, is beyond the scope of this paper; however, there is some evidence of direct treatment of traumatic lesions.

Fractures

Historical, iconographic and ethnographic sources suggest that there was knowledge of how to treat fractures in the past,[64–67] and traditional living populations today also have systems and knowledge for dealing with trauma.[68] Occasionally there is also direct evidence,[69] but there has been little attention paid to determining whether documented knowledge can be displayed in the skeletal evidence for trauma. Correlating evidence and efficiency in healing of long bone fractures with contemporary historical data is possible in some British material but, with some exceptions[2,15–17,21], little attempt has been made to do this worldwide. Although some researchers make comments on how well fractures have healed and whether there may have been therapeutic intervention, few take the data any further, something which should be of interest to biological anthropologists. Figures 4 and 5 illustrate two tibial fractures from different Anglo-Saxon sites which reveal very different healing; does this reflect the availability or not of treatment in different populations?

Figure 4 – Fractured right tibia (Anglo-Saxon) with normal left tibia for comparison. Healing is good with no angulation, overlap or lack of apposition: this suggests possible treatment.

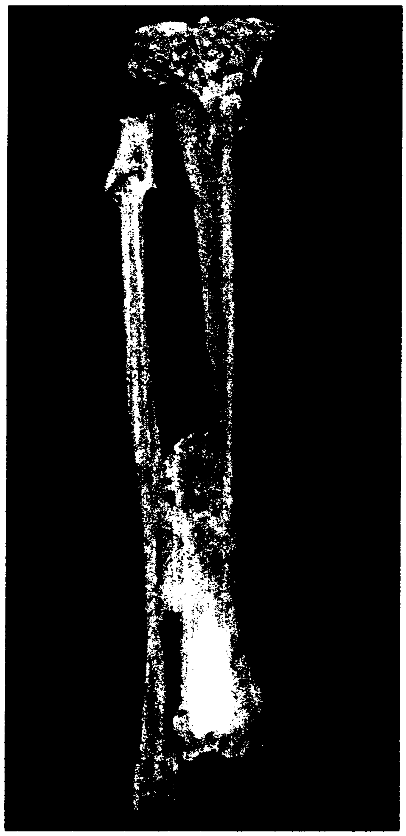

Figure 5 – Fractures to tibia and fibula (Anglo-Saxon). There is overlap and lack of apposition of the broken ends; this suggests lack of treatment.

Amputation

Amputations (surgical/accidental) of limbs may be classified as fractures and may have been performed as a result of complications of a severe fracture. They have also been described in historical literature and depicted artistically; rarely, however, are they described in skeletal evidence, and examples almost always have evidence of healing.[19,70–73] This arises from the problem of differentiating between unhealed peri-mortem (sustained shortly before or at the time of death) and post-mortem fractures. It is highly probable that many people undergoing amputation in the past died at the time of the operation, probably from blood loss and shock, and therefore there would be no evidence of healing on the amputated bone. Clearly, as seen in illustrations, people did undergo amputations and were provided with crutches and prostheses with which to move around post-operatively.[74] When recording possible amputations, examination of the edges of the cut is essential to prevent over-diagnosis, although the problem of 'weathering' of peri-mortem cut edges post-mortem must be considered.

Trepanation

Trepanations (which cover all surgically induced holes in the skull) or trephinations (which describe only holes made by a trephine or drill) are the surgical removal of a piece of bone from the skull and are also a form of treatment. They can also be classified as fractures and their history goes back into the prehistoric period where successful examples are apparent (i.e. the person survived the operation). Many reviews have been published of this remarkable operation.[1,3,4,6–8,75–77] While some cases are associated with head injuries,[20,78] others do not have any indication of why the trepanation was done, although headaches, migraine and epilepsy are claimed to have been treated using trepanation in the past. Trepanations have been documented around the world from all periods[79,80] and have been described and documented historically.[4,67] In British contexts, a prime researcher in the art of, and evidence for, trepanation was Parry[81] but later researchers have also contributed to the collective evidence for trepanation in Britain.[22,82,83] While there are many different types of trepanation (scrape, saw, bore and saw, gouge and drill), it was the more controllable scraping method that seems to have been used the most in British contexts, and it was also the one that appeared to heal, i.e. the person survived the operation. However, in the past, the risk of infection being introduced into the brain tissue via the operation must have been high, and it is likely that cerebral infection post-operatively would have led to the death of the unfortunate individual. When recording trepanations, in addition to the site of operation, type of trepanation, and characteristics of the edges of the opening, it is advisable to note any evidence of infection around the site. Of course the possibility that holes in the skull may be post-mortem must be ruled out by considering the characteristics of the edges of the hole. In addition, the consideration of the many differential diagnoses for holes in the skull should be considered, e.g. enlarged parietal foramina and neoplastic disease.[8]

LIMITATIONS OF THE DATA

The limitations of studying fractures in the past need some discussion. As for any other pathological condition, it is preferable to have the whole skeleton for study so that fracture patterning can be observed. For example, if one of the forearm or lower leg bones is fractured, observation of the other bone (and the opposite side to gain an impression of the level of deformity on healing) helps with interpretation. It is particularly important to look at fracture patterning, as in certain circumstances one may expect to see fractures occurring in specific parts of the body as a result of a particular traumatic incident. For example, interpersonal violence may result in head (especially the face), neck and forearm injuries.[84] However, forearm (parry) fractures alone do not necessarily mean interpersonal violence as they can be caused by falls.

Many people publish data on fractures with reference to age at death but it is virtually impossible to ascertain when a person sustained a fracture in life once the fracture is healed; was it 1, 5 or 10 years before death? It is only if the fracture is in the early stages of healing that age at death is directly relevant (of course, the older you are the more fractures you are likely to have sustained, as for any pathological condition). Very few fractures are observed in non-adults recovered from archaeological contexts, even though it is likely that in the past, as today, childhood fractures were a common occurrence. This absence of fractures seen in the young is probably because the skeleton is rapidly growing and if a bone is fractured then the fracture will heal quickly and even become invisible when viewed radiographically. However, the observation of bowing of bones both in adult and non-adult skeletons,[85] or shortened but normal-looking bones, may indicate old fractures. It is, however, interesting to note reports of accidents in children documented in historical data,[86] and it is probably here that more data on trauma (and other health problems) in children may be gleaned. Looking at typical childhood fractures in adult skeletal material may also provide clues to data for the younger part of the population. For example, fractures in the elbow region are common in children but rare in adults,[26] but fractures of the scaphoid and femur neck are uncommon in children. In addition, fractures to the distal radius (Colles' fractures) are the commonest fracture today in people > 40 years, especially females.[26] Observation of the bone elements affected in relation to age may aid us in identifying fracture occurrence in the growing years, even if the hard evidence is unavailable.

As all bones are not radiographed in palaeopathological work, very well healed fractures will not be detected. Recently sustained (peri-mortem) fractures are difficult to identify archaeologically because no healing has taken place. Even taking into account the particular fracture patterning determined by the characteristics of 'fresh' as opposed to archaeological bone[4] can be potentially misleading, as post-mortem breaks occurring while the bone still retains its highly collagenous 'fresh' composition would display similar fracture patterning and colouration to peri-mortem fractures. Also, a problem in identification may arise if the edges of a peri-mortem fracture have been weathered due to burial in the ground. Finally, stress induced fractures may also be hard to identify because they are often manifest as hairline fractures and, even if radiographed, they may not be obvious; tibiae, fibulae and metatarsals are the commonest bones affected.[26] Despite these limitations, there is a wealth of evidence available from a study of trauma.

RECOMMENDATIONS FOR RECORDING FRACTURES

Recommendations for recording fractures should follow published guidelines[17,18] with additional data,[87] according to the question being asked of the material. The initial, general and detailed description of the injury is the pre-requisite for more detailed work (Table 1). There are certain features that should always be recorded. These include fracture position using anatomical terms and type of fracture (e.g. is there any underlying pathology). In addition, the state of healing and any associated deformity, such as apposition, overlap, linear or rotational deformity (describe the distal fragment in relation to the proximal), and infection or joint degeneration (assuming these occur after the fracture and not before, and thus are complications) should be noted. Looking at the types of fracture and bone fractured, and comparing that information with clinical data may give an insight into treatment in the past. For example, forearm fractures and femoral shaft fractures often lead to considerable deformity and need either internal fixation and/or considerable traction to treat them. In archaeological contexts poorly aligned forearm and femoral fractures are recognized, perhaps indicating problems with treatment (Figure 6), but occasionally good results are seen which may reflect either careful and effective therapy or just good luck (Figure 7). Detailed descriptions of the state of healing of the fracture observed may reveal definite healing, non-union or non-union due to the person dying before union could take place. Figures 8 and 9 show examples of what the author believes to be clear non-union, and non-union due to healing being halted by death.

Table 1 – Fracture recording (macroscopic): features to note.

1	Age and sex of individual
2	Bone affected
3	Side affected
4	Fracture position (proximal, mid, distal for a long bone, for example; use anatomical terms)
5	Fracture type
6	State of healing (healed, unhealed, healing, woven/lamellar/mixed bone)
7	Evidence of infection (pitting, new bone formation, osteomyelitis)
8	Evidence of underlying pathology
9	Evidence of joint degeneration in adjacent joints
10	Evidence of linear/rotational deformity in degrees (measure on radiograph[15])
11	Amount of overlap/apposition in millimetres (measure on radiograph[15])
12	Alignment of bone (consider features 10 and 11)

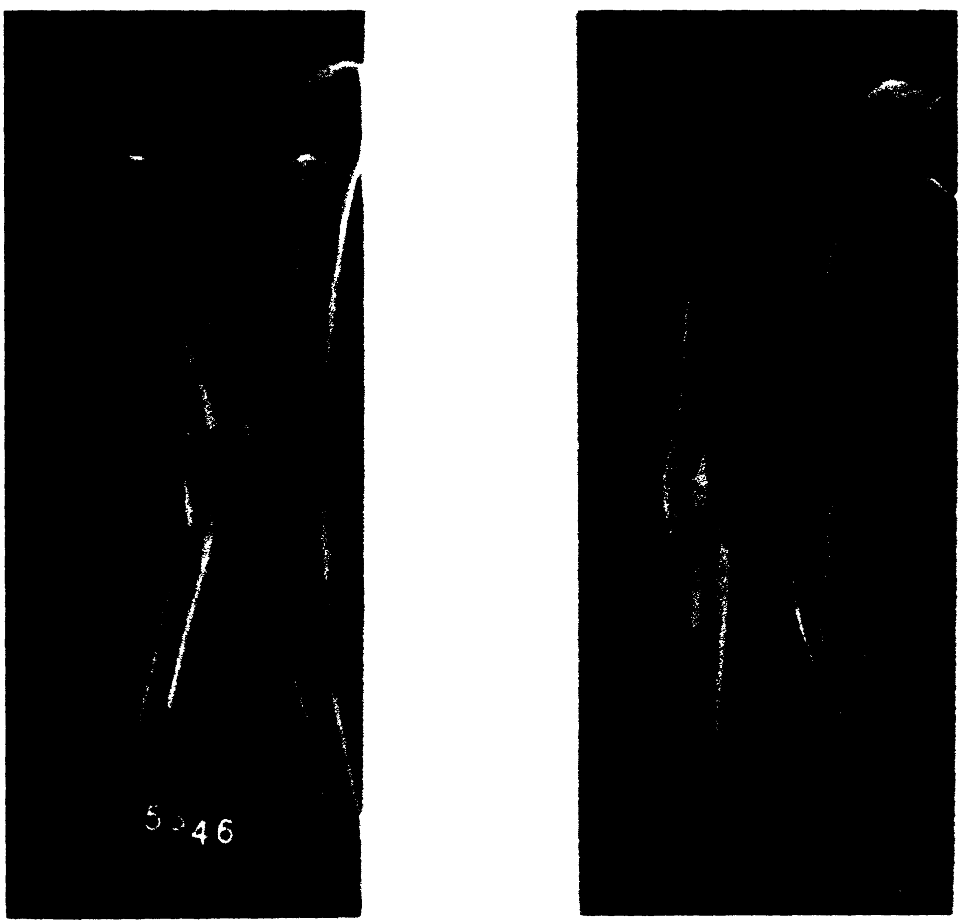

Figure 6 – Poorly aligned forearm fractures (later medieval).

Figure 7 – Well-aligned forearm fractures (post-medieval).

Figure 8 – Non-union of ulna fracture (California, USA).

Figure 9 – Non-union of rib fracture, probably due to premature death of the individual – note bone formation at ends (Romano-British).

In addition to macroscopic recording, a radiograph of the fracture should be taken (minimum of two views, antero-posterior and medio-lateral). This aids in collecting the previously described data (particularly state of healing and deformity). For example, the actual type of fracture may not be obvious macroscopically, and the state of healing becomes more visible with a radiograph (e.g. is the fracture line visible?). In addition, measurements of overlap, apposition and linear deformity are most accurately measured on a radiograph,[15] and pseudopathological features visualized and noted. The radiography of trauma, of course, is documented in many excellent texts,[32] which aid in interpretation of archaeological material. Features of the radiographic picture should also be recorded (Table 2).

Table 2 – Fracture recording (radiographic): additional features to note.

1	X-ray view taken: antero-posterior, medio-lateral, etc.
2	Fracture type; may be different from that observed macroscopically
3	Visibility of fracture line (clearly visible, partially obliterated, totally obliterated)
4	Is there cortical and cancellous continuity? (links to features 3 and 5)
5	State of healing; is the bone formed opaque (more recent) or translucent (older and remodelled)? – links to features 3 and 4
6	Evidence of shortening of affected limb (if long bone): measure on radiograph and compare with opposite side
7	Evidence of infection (new bone formation, osteomyelitis)
8	Evidence of underlying pathology (e.g. osteoporosis, neoplastic disease)
9	Evidence of joint degeneration in adjacent joints (e.g. subchondral cysts)
10	Evidence of linear/rotational deformity (measure linear on radiograph)
11	Amount of overlap/apposition of bone fragments (measure on radiograph)
12	Alignment of bone

The most important point to note is that, as for any other pathological lesions in skeletal remains, the total number of bones present for observation for the population sample under consideration should be known so that *actual* prevalence rates can be calculated. Both individuals affected, and bones affected as a percentage of bones should be recorded.[15] Additionally, the portion of the bone present needs to be noted. For example, if Colles' fractures are being recorded, the number of distal radii present is needed to determine prevalence rates. This means that if the original basic data exists for a population then comparisons can be made between groups.[15] Finally, of course, the patterning of trauma should be considered by age, sex and status, and in socio-cultural environmental context which will aid considerably in interpretation; in British contexts there is also an abundance of contemporary historical data for later periods with which to interpret patterns of trauma. The value of the recording system described has been illustrated already and shows the detailed information retrievable from the data recorded about fracture patterning in populations.[15–18]

While the emphasis here is on how to record and interpret fracture data, in the UK (and elsewhere) emphasis must be placed on better cooperation between biological anthropologists and archaeologists, both on and off site. Careful excavation and recovery of all bones,[88] and meticulous informed processing of material, with detailed recording on site, can contribute significantly to the final interpretation of a sample population's trauma patterns. For example, good clear photographs of skeletons *in situ* may give an indication of trauma complications that will probably not be evident once the skeleton has been removed from the ground. Figure 10 shows an individual who had sustained a femoral neck fracture and clearly had a shortened leg. In addition, purely by accurate recording of the skeleton in the ground, fracture complications such as nerve or blood vessel disruption may be revealed. In the case of a supracondylar fracture to the humerus, for example, injury to the brachial artery can occur with Volkmann's ischaemic contracture. Here there can be replacement of affected muscles by fibrous tissue and contracture of the wrists and fingers into flexion; sensory and motor paralysis of the hand can also occur.[26] Flexion contracture may only be recognized in the burial context, although lesions to the phalanges of the hand may be apparent (also seen in leprosy[89]). Loss of function as a result of trauma may also be revealed in the presence of osteoporosis or atrophy of the affected limb.

Most people working on trauma will only have access to macroscopic and radiographic techniques for recording, but there has been some work using more sophisticated methods of analysis. For example, there are problems of diagnosing osteoporosis in archaeological material because of post-mortem changes in bone leading to loss of bone mass. In such cases, the study of microfractures using scanning electron microscopy (SEM) may potentially provide information about osteoporotic fractures in the spine, wrist and hip, as microfractures can occur in osteoporotic bones.[90] It should not be forgotten that microfractures can also occur in bones subject to stress in young adults. Furthermore, computed tomography (CT), i.e. taking cross-sectional images at 1.5–10 mm intervals of a subject, be it of a bone or a body, has been little used in the investigation of trauma (but see Notman[91] for use of this method on identification of rib fractures in a mummy). The identification of non-adult, well healed fractures and stress fractures using CT, and the microscopic evaluation of the surfaces of possible peri-mortem fractures using SEM, may help to solve some of the limitations of trauma study outlined above.

Figure 10 – Skeleton from St Giles by Brompton Bridge, North Yorkshire.

CONCLUSIONS

Clearly there is much to be gained from a study of trauma. However, and not only in British contexts, there needs to be more concentration on the population and not the 'individual' in the future rather than a further proliferation of interesting cases of trauma. In this way more meaningful information about patterns of trauma (and its treatment) may be gained. In Britain, as there has been so little work done at a population level, gaps in knowledge are large and therefore we are only just beginning. Some points need emphasizing for future work in this field:

- Population studies are of prime importance, with a stated hypothesis to test.
- Prevalence rates as a percentage of bones available for study, plus people (individuals) affected, must be stated in any report, or at least data provided to do these calculations.
- Detailed descriptions of traumatic lesions are essential. For fractures interpretations should work from a clinical base, and anatomical position, state of healing, and complications evident, with radiographic supporting evidence, are needed.
- Prevalence rates by age, sex, and status are required, where possible.
- Trauma needs to be considered chronologically and geographically.

- Data should to be interpreted with reference to both the cultural and funerary context. For example, are there differences in trauma between urban and rural, and monastic and lay populations, and are the fractures better healed in a hospital as opposed to non-hospital context?
- Sample representivity must be considered (i.e. is it biased?). For example, if a battlefield cemetery were being considered then many fractures (probably many unhealed) would be expected compared with a general cemetery, and a preponderance of males is also likely.
- Is there any evidence for treatment? For example, are the bones well aligned and healed? Is there contemporary evidence for the period for treatment of fractures?
- Case studies need collating for British contexts.
- Data need comparing to other samples worldwide.
- A consideration of levels of disability associated with traumatic lesions, and how disability was viewed and treated in the past, would be of value in determining attitudes to disability.

Much remains to be done. However, there is a lot of data already extant in published and unpublished skeletal reports, case and the occasional sample study. However, if work on British material could start from a sound base with established and accepted standardized recording methods many of the recommendations above would be achievable. Population prevalence rates of trauma for age, sex, and status, in geographical, funerary, chronological and cultural context are the key areas for consideration with a clinically based macroscopic and radiographic recording system for trauma, and should be a focus of attention for biological anthropologists working in Britain.

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